CLAIMS

1. A stall detection and recovery system for a gas turbine engine, the system comprising surge detection means for detecting an engine surge and proving a surge detection signal for indicating said engine surge, stall detection means to provide a stall detection signal relating to a condition of gas flowing through the engine, and stall recovery means to receive said surge detection signal and said stall detection signal, said stall recovery means being arranged to control combustor operating means whereby when the stall detection signal indicates an engine stall, the stall recovery means controls the combustor operating means to effect recovery from the stall.

2. A system according to claim 1 wherein the combustor operating means comprises means to supply fuel to the combustor, and an ignitor for igniting the fuel.

3. A system according to claim 1 wherein the stall recovery means operates to interrupt momentarily said supply of fuel and to ignite the fuel supplied to the engine after said momentary interruption.

4. A system according to claim 1 wherein the condition of the gas to which the stall detection signal relates is the pressure of the gas.

5. A system according to claim 1 including delay means to impart a delay of a predetermined time to the surge detection signal, whereby the stall recovery means operates to effect recovery from the stall a predetermined time after the surge detection signal indicates an engine surge providing the stall detection signal still indicates an engine stall.

6. A system according to claim 5 wherein the predetermined time is in the region of 0 to 10 seconds.

7. A system according to claim 6 wherein the predetermined time is in the region of 0.1 to 10 seconds.

8. A system according to claim 7 wherein the predetermined time is in the region of 0.1 to 1 second.

9. A system according to claim 8 wherein the predetermined time is substantially 0.5 seconds.

10. A system according to claim 5 wherein the surge detection means provides a surge signal, indicative of a surge having been detected, and the surge signal is received by the delay means which imparts said delay to the surge signal.

11. A system according to claim 10 wherein the surge detection means comprises combustor monitoring means to monitor a condition of the gas in the combustor.

12. A system according to claim 11 wherein the combustor monitoring means monitors combustor pressure.

13. A system according to claim 1 wherein the stall detection means comprises a pressure monitoring arrangement for monitoring the pressure of the gas at a region of the engine and providing a pressure signal.

14. A system according to claim 13 wherein the stall detection signal and the surge detection signal are transmitted through the stall recovery means for controlling the supply of fuel and the ignitor as aforesaid.

15. A stall detection system for a gas turbine engine, comprising a monitoring arrangement for monitoring the condition of gas flowing through a first region of the engine and providing a first signal relating to said condition of the gas at the first region, and for monitoring the condition of gas flowing through the engine at a second region of the engine and providing a second signal, processing means for processing the first, and second signals to provide a processed signal, means for providing a threshold signal, the processing means further including a comparator means for comparing on

the processed signal with the threshold signal and providing an output signal relating to the comparison of the first and second processed signals.

16. A system according to claim 15 wherein the monitoring arrangement comprises a pressure monitoring arrangement for monitoring the pressure of the gas of said regions, whereby the first and second signals are first and second pressure signals.

17. A system according to claim 11 and further including processing means to process at least one of the pressure signals.

18. A system according to claim 11 wherein the pressure monitoring arrangement comprises a first pressure measuring means for measuring the pressure at a first region of the engine and providing a measured first pressure signal, being said pressure signal, and a second pressure measuring means for measuring the pressure at a second region of the engine and providing a measured second pressure signal.

19. A system according to claim 18 wherein the second region of the engine is the combustor, and the measured second pressure signal relates to the pressure in the combustor.

20. A system according to claims 18 wherein the processing means comprises filter means for filtering the first pressure signal, the filter means providing a first filtered signal indicative of the time average value of the first pressure signal, a second filtered signal indicative of high values of the first pressure signal, and a third filtered signal indicative of low values of the first pressure signal.

21. A system according to claim 20 wherein the second filtered signal is indicative of maximum peaks of the first pressure signal, and the third filtered signal is indicative of minimum peaks of the first pressure signal.

22. A system according to claim 17 wherein the processing means further includes comparator means for providing a first difference signal, being the difference between

the first filtered signal and the second filtered signal, and for providing a second difference signal, being the difference between the first filtered signal the third filtered signal.

23. A system according to claim 22 wherein the processing means further includes gate means, for transmitting the lowest of the first and second difference signals.

24. A system according to claim 23 wherein the processing means further comprises multiplying means for multiplying said transmitted difference signal by a predetermined factor and provide a multiplied pressure signal.

25. A system according to claim 24 wherein the predetermined factor is 2.

26. A system according to claim 24 comprising fixed signal transmission means for transmitting a predetermined second pressure signal.

27. A system according to claim 26 wherein the predetermined second pressure signal is a signal relating to a pressure which is lower than the expected pressure of the second pressure signal during normal running of the engine, and higher than the pressure in the second region of the engine during engine start or sub-idle operation or when the engine is unlit.

28. A system according to claim 26 further including second processing means to process the second measured pressure signal and the predetermined second pressure signal, the second processing means comprising further gate means for transmitting the highest of the measured second pressure signal and the predetermined second pressure signal.

29. A system according to claim 28 wherein the stall detection means comprises divider means to divide the multiplied pressure signal by the transmitted second pressure signal to provide a divided signal.

30. A system according to claim 29 wherein the stall detection means further comprises a comparator device to compare the divided signal with a threshold signal, whereby in the event of the divided signal being greater than the threshold signal, the comparator device provides a stall output signal.

31. A system according to claim 30 wherein the stall detection means comprises integration means to receive the stall output signal, the integration means producing said stall detection signal which indicates that a stall has been detected.

32. A system according to claim 31 wherein the integration means is a fault integrator.

33. A stall detection and recovery method for a gas turbine engine, the method comprising detecting an engine surge and proving a surge detection signal for indicating said engine surge, detecting an engine stall and providing a stall detection signal relating to a condition of gas flowing through the engine, and providing a stall recovery means to receive said surge detection signal and said stall detection signal, said stall recovery means being arranged to control combustor operating means whereby when the stall detection signal indicates an engine stall, the stall recovery means controls the combustor operating means to effect recovery from the stall.

34. A method according to claim 33 wherein the combustor operating means comprises means to supply fuel to the combustor, and an ignitor for igniting the fuel.

35. A method according to claim 32 wherein the recovery from stall comprises interrupting momentarily said supply of fuel and to ignite the fuel supplied to the engine after said momentary interruption.

36. A method according to claim 33 wherein the condition of the gas to which the second signal relates is pressure of gas.

37. A method according to claim 33 wherein a delay of a predetermined time is imparted to the surge detection signal, whereby the stall recovery means operates to effect recovery from the stall said predetermined time after the surge detection signal indicates an engine surge providing the stall detection signal still indicates an engine stall.

38. A method according to claim 37 wherein the predetermined time is in the region of 0 to 10 seconds.

39. A method according to claim 38 wherein the predetermined time is in the region of 0.1 to 10 seconds.

40. A method according to claim 39 wherein the predetermined time is in the region of 0.1 to 1 second.

41. A method according to claim 40 wherein the predetermined time is substantially 0.5 seconds.

42. A method according to claim 37 wherein a surge signal is provided, indicative of a surge having been detected, said delay is imparted to the surge signal.

43. A method according to claim 33 including monitoring the pressure of the gas at a region of the engine and providing a pressure signal.

44. A method according to claim 43 comprising providing combustor monitoring means to monitor a condition of the gas in the combustor.

45. A method according to claim 44 wherein the combustor monitoring means monitors combustor pressure.

46. A method according to claim 45 wherein the stall detection signal and the surge detection signal are transmitted through the control means for controlling the supply of fuel and the ignitor as aforesaid.

47. A stall detection method for a gas turbine engine, comprising monitoring the condition of gas flowing through a first region of the engine and providing a first signal relating to said condition of the gas at the first region, monitoring the condition of gas flowing through the engine at a second region of the engine and providing a second signal, processing the first, and second signals to provide a processed signal, providing a threshold signal, comparing the processed signal with the threshold signal and providing an output signal relating to the comparison of the first and second processed signals.

48. A method according to claim 47 wherein the condition monitored is the pressure of the gas at said region.

49. A method according to claim 48 further including processing the pressure signal.

50. A method according to claim 48 wherein the step of monitoring the pressure comprises measuring the pressure at a first region of the engine and providing a measured first pressure signal, being said pressure signal, and measuring the pressure at a second region of the engine and providing a measured second pressure signal.

51. A method according to claim 50 wherein the second region of the engine is the combustor, and the measured second pressure signal relates to the pressure in the combustor.

52. A method according to claim 50 including filtering the first pressure signal, to provide a first filtered signal indicative of the time average value of the first pressure signal, a second filtered signal indicative of high values of the first pressure signal, and a third filtered signal indicative of low values of the first pressure signal.

53. A method according to claim 52 wherein the second filtered signal is indicative of maximum peaks of the first pressure signal, and the third filtered signal is indicative of minimum peaks of the first pressure signal.

54. A method according to claim 49 comprising providing a first difference signal, being the difference between the first filtered signal and the second filtered signal, and providing a second difference signal, being the difference between the first filtered signal the third filtered signal.

55. A method according to claim 54 including transmitting the lowest of the first and second difference signals.

56. A method according to claim 55 including multiplying said transmitted difference signal by a predetermined factor to provide a multiplied pressure signal.

57. A method according to claim 56 wherein the predetermined factor is 2.

58. A method according to claim 56 including transmitting a predetermined second pressure signal.

59. A method according to claim 58 wherein the predetermined second pressure signal is a signal relating to a pressure which is lower than the expected pressure of the second pressure signal during normal running of the engine, and higher than the pressure in the second region of the engine during engine start or sub-idle operation or when the engine is unlit.

60. A method according to claim 58 further including processing the second measured pressure signal and the predetermined second pressure signal, and transmitting the highest of the measured second pressure signal and the predetermined second pressure signal.

61. A method according to claim 22 including dividing the multiplied pressure signal by the transmitted second pressure signal to provide a divided signal.

62. A method according to claim 61 including comparing the divided signal with a threshold signal, whereby in the event of the divided signal being greater than the threshold signal, a stall output signal is provided.

63. A method according to claim 62 including transmitting the stall output signal to integration means to receive the stall output signal, the integration means producing said stall detection signal which indicates that a stall has been detected.

64. A method according to claim 63 wherein the integration means is a fault integrator.

65. A gas turbine engine incorporating a system according to claim 1.